

Silicon-based quantum computing: The path from the laboratory to industrial manufacture

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This colloquium will be held **ONLINE**.

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In this talk I will give an overview of the development of silicon-based quantum computing (QC), from the basic science through to its prospects for industrial-scale commercialization based on CMOS manufacturing. I begin with Kane's original proposal [1] for a silicon quantum computer, conceived at UNSW in 1998, based on single donor atoms in silicon, and will review the first demonstrations of such qubits, using both electron spins [2,3] and nuclear spins [4]. I then discuss the development of SiMOS quantum dot qubits, including the demonstration of single-electron occupancy [5], high-fidelity single-qubit gates [6], and the first demonstration of a two-qubit logic gate in silicon [7], together with assessments of silicon qubit fidelities [8,9]. I will also explore the technical issues related to scaling a silicon-CMOS based quantum processor [10] up to the millions of qubits that will be required for fault-tolerant QC, including the recent demonstration of silicon qubit operation above one kelvin [11].

References

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| [2] A. Morello <i>et al.</i>, Nature 467, 687 (2010). | [9] W. Huang <i>et al.</i>, Nature 569, 532 (2019). |
| [3] J.J. Pla <i>et al.</i>, Nature 489, 541 (2012). | [10] M. Veldhorst <i>et al.</i>, Nature Commun. 8, 1766 (2017). |
| [4] J.J. Pla <i>et al.</i>, Nature 496, 334 (2013). | [11] H. Yang <i>et al.</i>, Nature 580, 350 (2020). |
| [5] C.H. Yang <i>et al.</i>, Nature Commun. 4, 2069 (2013). | |
| [6] M. Veldhorst <i>et al.</i>, Nature Nanotechnol. 9, 981 (2014). | |
| [7] M. Veldhorst <i>et al.</i>, Nature 526, 410 (2015). | |